Surgical Neurology International

SNI: Spine, a supplement to Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Editor: Nancy E. Epstein, MD Winthrop University Hospital, Mineola, NY, USA

Commentary: Utility of the O-Arm in spinal surgery

Nancy E. Epstein

Chief of Neurosurgical Spine and Education, Winthrop University Hospital, Mineola, NY 11501, USA

E-mail: *Nancy E. Epstein - nancy.epsteinmd@gmail.com
*Corresponding author

Received: 26 October 14 Accepted: 10 November 14 Published: 30 December 14

This article may be cited as:
Epstein NE. Commentary: Utility of the O-Arm in spinal surgery. Surg Neurol Int 2014;5:S517-9.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2014/5/16/517/148001

Abstract

Background: More studies report the intraoperative benefits vs. risks of utilizing the O-Arm in performing pedicle screw insertion in spinal surgery.

Methods/Results: Several studies document the utility of CT-guided O-arm placement of pedicle/lateral mass screws. Singh *et al*. documented the efficacy of CT guided-O Arm placement of pedicle screws and lateral mass screws in the upper cervical spine.[4] Specifically, 10 patients with unstable hangman's fractures (ages 17-80) required 52 screws; C2 pedicle screws (20), C3 lateral mass screws (20), C4 lateral mass screws (12) and one C2 pedicle screw. Of these only 5% were misplaced, and none had new neuorlogical deficits. Kim *et al*. demonstrated the safety/efficacy of the CT/O-arm in minimally invasive spine surgery (MIS) (posterior percutaneous spinal fusions).[1] Of 290 pedicle screws, 280 (96.6%) were acceptably placed. Kotani *et al*. compared the placement of 222 pedicle screws (29 patients operated upon with CT-based navigation) vs. 416 screws (32 having surgery using O-arm-based navigation); postoperative CT studies confirmed the accuracy of screw placement, and no significant differences in the frequency of grade 2-3 perforations between the two groups. Nelson *et al*. analyzed the radiation exposure delivered to the operating room staff utilizing C-arm fluoroscopy (C-arm), portable X-ray (XR) radiography, and portable cone-beam computed tomography (O-arm); the surgeon and assistant were exposed to higher levels of scatter radiation from the C-arm, with a 7.7-fold increase in radiation exposure on the tube vs. detector sides.[3]

Conclusion: There are several pros and a few cons (radiation dosage) for the use of the O-arm in spine surgery.

Key Words: O Arm, radiation dosage, spinal surgery, utility

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.148001

Quick Response Code:

COMMENTARY

Utility of the O-Arm in spinal surgery

There have been variable reports regarding the intraoperative benefits and risks of utilizing the O-Arm in performing pedicle screw insertion in spinal surgery. A cursory review of the literature demonstrates multiple pros and cons.

Efficacy of CT- guided O-arm placement of pedicle/lateral mass screws

Singh *et al*. documented the efficacy of CT guided-O Arm placement of pedicle screws and lateral mass screws in the upper cervical spine.[4] Specifically, 10 patients with unstable hangman's fractures (ages 17-80) required 52 screws; 20 were placed in the C2 pedicle, 20 in the C3 lateral mass, and 12 in the C4 lateral mass. Of these, only

one C2 pedicle screw (5%) was misplaced. Additionally, no patients sustained new deficits/morbidity attributable to inaccurate screw placement.

Better outcomes of CT / O-arm placement of percutaneous pedicle screws

Kim *et al*. evaluated the safety/efficacy of intraoperative CT image-guided navigation (IGN) with the O-arm used in minimally invasive spine surgery (MIS).[1] Their aim was to document whether real-time O-Arm CT-IGN increased the safety/accuracy of pedicle screw placement for posterior percutaneous spinal fusions. All patients had postoperative CT scans to confirm the location of screws within the pedicles or whether there was a breach. The breaches were defined by the following Grades; Grade 1 (<2 mm), Grade 2 (2- 4 mm), and Grade 3 (>4 mm). Additionally, anterior vertebral body breaches were noted. Of 290 pedicle screws, 280 (96.6%) were acceptably placed without cortical wall or anterior breaches. Only 10 breaches (3.4%) occurred; 5 were lateral, 4 were medial, and 1 was anterior. Despite the one Grade 3 breach, there were neither vascular or neurological complications, and no patient required revision surgery.

No significant difference in accuracy of O-Arm vs. conventional CT-based techniques for pedicle screw placement in scoliosis surgery, but a reduced time for screw placement

Kotani *et al*. commented on the increased accuracy of pedicle screw placement in scoliosis surgery utilizing O-arm navigational vs. conventional CT-based techniques.[2] Their retrospective study compared the placement of 222 pedicle screws (29 patients using CT-based navigation: Group C) vs. 416 screws (32 patients using O-arm-based navigation: Group O). Postoperative CT studies confirmed the accuracy of screw placement: Grade 0: No perforation, grade 1: Perforation <2 mm, grade 2: Perforation ≥2 and <4, and grade 3: Perforation ≥4 mm). Statistically, there was " no significant difference" in the frequency of grade 2-3 perforations between the two groups, but the time for registration was significantly reduced (5.4 ± 1.1 vs. 10.9 ± 3) when using the O-arm.

Radiation dose using intraoperative C-arm fluoroscopy, portable x-ray, and ct (O-arm) utilized in spinal surgery

Nelson *et al*. analyzed the radiation exposure delivered to the operating room staff utilizing C-arm fluoroscopy (C-arm), portable X-ray (XR) radiography, and portable cone-beam computed tomography (O-arm).[3] Using a plastic phantom, they evaluated dose/scatter exposures at common positions occupied by OR staff. They found that "single lateral (LAT)/posterior-anterior entrance patient radiation exposure for C-arm was on average 116/102 mR, single-exposure XR for LAT/anterior-posterior (AP) was 3,435/2,160 mR, and single-exposure O-arm for LAT/AP was 4,360/5,220 mR". They concluded that the surgeon and assistant were exposed to higher levels of scatter radiation from the C-arm, with a 7.7-fold increase in radiation exposure on the tube vs. detector sides. The anesthesiologist was exposed to the highest scatter from the O-arm, the radiologic technologist's exposure was highest for X-ray. They concluded that the choice to use these different modalities should take into account the dosage of radiation exposure to the entire operating room staff.

Personal comment

There appear, indeed, to be multiple pros and cons for using the O-arm. I personally have not used it, and know that many members of the board, who have not commented, also have not employed it in their surgical procedures. A major cause of concern is the significant radiation dose not only for the surgeon, but the operative team as well. Perhaps selective use of the device, only where it is felt it will truly impact outcome, is worthwhile.

REFERENCES

1. Kim TT, Drazin D, Shweikeh F, Pashman R, Johnson JP. Clinical and radiographic outcomes of minimally invasive percutaneous pedicle screw placement with intraoperative CT (O-arm) image guidance navigation. Neurosurg Focus 2014;36:E1.
2. Kotani T, Akazawa T, Sakuma T, Koyama K, Nemoto T, Nawata K, *et al*. Accuracy of Pedicle Screw Placement in Scoliosis Surgery: A Comparison between Conventional Computed Tomography-Based and O-Arm-Based Navigation Techniques. Asian Spine J 2014;8:331-8.
3. Nelson EM, Monazzam SM, Kim KD, Seibert JA, Klineberg EO. Intraoperative fluoroscopy, portable X-ray, and CT: patient and operating room personnel radiation exposure in spinal surgery. Spine J 2014;14:2985-91.
4. Singh PK, Garg K, Sawarkar D, Agarwal D, Satyarthee GD, Gupta D, *et al*. Computed tomography-guided C2 pedicle screw placement for treatment of unstable hangman fractures. Spine (Phila Pa 1976) 2014;39:E1058-65.

COMMENTS FROM MEMBERS OF THE BOARD OF SNI: SPINE

Dr. Dennis Maiman

I'm an old man now, and have viewed many-if not most-of the new developments that were going to change everything in spine surgery with a measure of disdain. The ideal technology should be no more than an affirmation of the surgeon's capabilities, and does not substitute for experience and judgment. As a crutch, however, it can be useless or dangerous.

We now have extensive experience with the O arm combined with Stealth from C1 to the sacrum, but certainly do not use it universally. I do a lot of deformity surgery these days, and find it invaluable for screw targeting in a rotated/malaligned thoracolumbar spine. Indeed, I use it almost universally in the thoracic spine.

I've also found it to be quite helpful in vertebral tumor resections, and transoral approaches: Nice to know how deep you are, before you go too far! Similarly, our cranial surgeons have used it in skull base tumors and DBS.

Two comments, however: Much of our utilization could be done with preoperative CT and then Stealth. Furthermore, no one in my group would be crippled without it. I have little doubt our accuracy is improved, but we did these procedures before the O arm and do not regard it as the standard of care.

What I really fear is the surgeon who is not trained or experienced in the procedure being undertaken relying on the technology to get through it. A tool is only as good as its handler.

Dr. Paul Arnold

The use of intra-operative navigation in spine surgery, particularly the O-arm, has increased rapidly in the past several years. We now use it for nearly every pedicle screw case. It is most helpful in the upper thoracic spine, where the patient's arms and the current OR tables make it almost impossible to discern the appropriate anatomy. We also use it for deformity reduction assessment as well as three-dimensional cage placement assessment.

While there is a learning curve to becoming comfortable with the technology, once this is mastered, screw placement is relatively pain free. There is some time involved in the set-up as well as data acquisition, which is offset by the relatively straightforward placement of the screws, without having to stop and obtain a fluoroscopy image with each screw insertion. The patient is subject to the equivalent of two intra-operative CT scans; this is somewhat offset by the fluoroscopy or x-ray exposure that would otherwise take place. We have been very happy with our screw placement accuracy using this technology, and we no longer image the patient while in the hospital. The initial cost to buy the technology is expensive, but we believe well worth it. We also use it for C1-C2 screws, and find it invaluable in this anatomic space.

(It is possible this technology will be the standard of care in the not-so-distant future for difficult cases; perhaps not in L4-5 degenerative spondylolisthesis. Woe to the surgeon who has this technology available and doesn't use it and then has a wayward screw that must be explained under oath).